

YAG(Ce)

Yttrium Aluminum Garnet

Scintillation Material

YAG(Ce) — Yttrium Aluminum Garnet doped with Cerium [chemical formula $\text{Y}_3\text{Al}_5\text{O}_{12}(\text{Ce})$] — is a non-hygroscopic, chemically inert inorganic scintillator. The wavelength of the maximum emission at 550nm is well matched to CCD sensitivity. YAG(Ce) is a reasonably fast scintillator with a relative light yield of 21% of NaI(Tl).

This material exhibits specific properties that make it an interesting candidate for electron microscopy applications instead of the phosphors commonly used:

- High electron conversion efficiency.
- Good resolution. YAG(Ce) is clear, not diffuse like phosphor screens.
- YAG(Ce)'s light yield increases linearly with the total energy of the electron beam, whereas the response of phosphors dramatically decreases.
- YAG(Ce) is mechanically rugged and long lasting.

- Good thermal conductivity ($13\text{Wm}^{-1}\text{K}^{-1}$) prevents local heating from a concentrated electron beam.

- The mechanical ruggedness and good thermal conductivity of YAG(Ce) provide a hardness to electron beams, and thus a long lifetime is expected.

- Vacuum compatibility.

Other possible applications include beta and X-ray counting, and electron and X-ray imaging screens. Its mechanical properties enable screens down to 0.030mm thick.

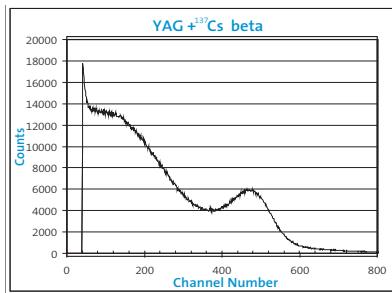


Figure 1. ¹³⁷Cs conversion electron spectrum

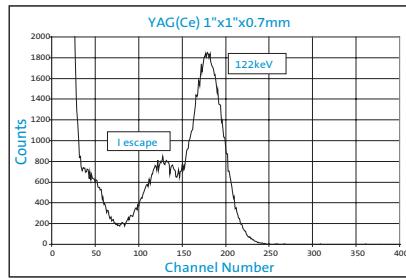


Figure 2. ⁵⁷Co spectrum

Properties –

| | | |
|----------------------------------|-------|------|
| Density [g/cm ³] | | 4.55 |
| Hardness (Mohs) | | 8.5 |
| Hygroscopic | | No |
| Wavelength of emission max. [nm] | | 550 |
| Refractive index @ emission max. | | 1.82 |
| Decay time [ns] | | 70 |
| Relative light output | | 15 |
| Light output, photons per keV | | 8 |



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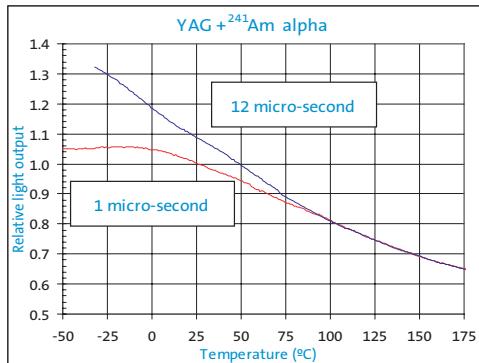


Figure 3. Temperature Response of YAG
(Data compiled by C. M. Rozsa)

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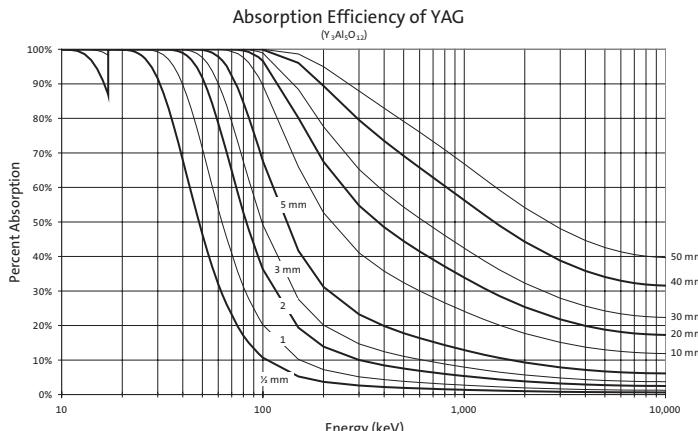


Figure 4. Gamma and X-ray absorption efficiency for various thicknesses of YAG.
Data compiled by C. M. Rozsa (presented in Saint-Gobain Crystals brochure
"Efficiency for Selected Scintillators.")

Table comparing principal properties of YAG, NaI and BGO

| Property | YAG(Ce) | NaI(Tl) | BGO |
|--|-------------------------|---------|------|
| Density (g/cm ³) | 4.55 | 3.67 | 7.13 |
| Decay time (ns) | 70 | 250 | 300 |
| Wavelength of emission max(nm) | 550 | 415 | 480 |
| Average temperature coefficient from 25 to 50°C (%/°C) | -0.24@1μs -0.34@12μs | -0.3 | 1.2 |
| Light output, photons per keV | 8 | 38 | 8.5 |